Resistivity change produced by stress change and its sensitivity -Estimation with the observational data at Aburatsubo site-

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We have conducted earth resistivity monitoring in order to verify that the resistivity of rocks is sensitive to stress changes, and analyzed data to estimate its sensitivity. The effects of stress on resistivity were practically shown by several laboratory experiments. Yamazaki (1966) observed the change in resistivity of partially saturated tuffs under uniaxial compression. The amplification factors of resistivity relative to strain ranged from 100 to 1000, and exponentially increase as strain become small. In laboratory test, however, we can hardly measure strain less than 10 to the -4th power because of the limitation of measurement. So, we have selected Aburatsubo as the observational site, where large stress change is produced by ocean tidal loading. Yamazaki (1966) sampled the tuffs for laboratory experiments at this site. Large strains on the order of 10 to the -6th power due to loading were observed by extensometers at this site. Yamazaki (1967) also reported resistivity fluctuations on the order of 10 to the -3rd power and concluded that the resistivity fluctuations were caused by the stress fluctuations. However, it is also well known that the fluctuations of sea level propagate landward with attenuation and delay near a coast like this site. In practice, the fluctuation in well water table about 2 m below from the ground level is observed. Therefore, there is a possibility that the observed resistivity fluctuation is caused by such a change in groundwater level. In order to clear up the cause of resistivity change at Aburatsubo site, we observed resistivity fluctuations with two observational arrays. Following Yamazaki (1967), we adopted 2 m spacing of electrodes at the beginning. In this electrode spacing (SPC 2), we mainly look at the resistivity change of the first layer. In addition to SPC 2, we began to run the other measurement adopting 10 m spacing (SPC 10) in order to look at the resistivity change in deeper fully saturated layer. Both SPC 2 and SPC 10 could observe long-term large change, and tidal fluctuations on the order of 10 to the -3rd power. But these polarities of tidal fluctuations were reversal each other. This polarity reversal can be explained principally in terms of the difference in polarity of the resistivity change against stress change according to the water conditions in rocks. However, long-term change in resistivity is similar to the reversed change in groundwater table, which show the existence of resistivity change produced by groundwater. Detail spectrum analysis demonstrated that resistivity measurements are affected by both of the stress and groundwater head fluctuations. In order to estimate the sensitivity of resistivity change to stress, we investigated the contribution of stress and groundwater head. Long-term resistivity fluctuations more than one day should be caused by only groundwater, because such a long-term fluctuation is absent in source of stress fluctuation (sea level fluctuation). So, we calculated a transfer function between long-term resistivity and groundwater change, and generated the resistivity fluctuations due to groundwater. In order to calculate the contribution of stress and groundwater to resistivity, we conducted the multiple linear regression analysis. The comparison of observed resistivity and rebuild resistivity by calculated contribution revealed that the result of analysis is quite good; the correlation coefficients are attained to 0.983. We estimated the amplification factors of resistivity to strain with the calculated contribution, and got the values 435 and -788, in partially and fully saturated rocks (negative value means the decrease in resistivity by the extension).